

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 03 MAY 2006

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Applicant's or agent's file reference PD53612PC00	FOR FURTHER ACTION	See Form PCT/PEA/416
International application No. PCT/EP2005/000523	International filing date (day/month/year) 20.01.2005	Priority date (day/month/year) 12.02.2004
International Patent Classification (IPC) or national classification and IPC INV. H04M1/03 H04R1/22 H04R1/28		
Applicant SONY ERICSSON MOBILE COMMUNICATIONS AB		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 10 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>		
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>		
Date of submission of the demand 20.06.2005	Date of completion of this report 03.05.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer de Biolley, L Telephone No. +31 70 340-3137	



INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2005/000523

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-8 filed with telefax on 24.04.2006

Claims, Numbers

1-8 filed with telefax on 24.04.2006

Drawings, Sheets

1/1 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☒ The amendments have resulted in the cancellation of:
 - ☐ the description, pages
 - ☒ the claims, Nos. 9
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:
 4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2005/000523

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

- 1 Reference is made to the following document:
D1: US 2002/136398 A1 (DUFOSSE STEPHANE ET AL) 26 September 2002 (2002-09-26)

- 2 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document):

An electro-acoustic communications unit (fig. 1, ref. 1) comprising :
a housing (fig. 1, ref. 2) with a wall, having a volume (fig. 1, ref. 3),
an acoustic driver (fig. 1, ref. 5) mounted to the wall (see paragraph 32),
an acoustic port (fig. 1, ref. 9),
where a desired frequency characteristics is achieved when engaging the exterior end
for the acoustic port with a user's ear (see paragraphs 34, 41 and fig. 4)

The subject-matter of claim 1 differs from D1 in that the housing is tightly sealed.
The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

- 3 The problem to be solved by the present invention may be regarded as how to provide an electro-acoustic communications unit that is capable to produce signals in alert mode and in phone mode with a desired frequency performance and essentially without distortion.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:
providing a tight seal to the housing is not known from, nor rendered obvious by the available prior art.

- 4 Claims 2-8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.

PCT/EP2005/000523

5 The subject-matter of independent claim 1 has an industrial applicability.

EAR PORT

TECHNICAL FIELD OF THE INVENTION

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The present invention relates to an electro-acoustic communications unit and a portable communication device for producing a desired frequency characteristics in alert and phone mode.

10 DESCRIPTION OF RELATED ART

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A portable communications unit, for instance of the type of a mobile phone, should be able to produce two types of acoustic signals, the alert type (high level) of signals in alert operation mode and the phone type (low level) of signals, typically the voice of the person to whom the user of said portable communications device is communicating, in phone operation mode. In order to produce acoustic output signals at these two different levels two different transducers have traditionally been used. However, since the reproduction demands of the alert signal have risen in connection with polyphonic ring signals, and since the importance of small sizes of the mobile phones has augmented, portable communications units, containing one

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transducer only, have been presented.

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In order to produce the two levels of acoustic signals, the same transducer is excited with two different electric signal levels. Also, in the phone mode the user typically holds the mobile phone against his/her ear, whereas in the alert mode the mobile phone is typically not held against someone's ear, but rather placed so that the mobile phone can send the acoustic signals into free air space. This difference of what the transducer faces in the phone mode as compared to the alert mode, means that the mobile phone experiences two different impedances, in an impedance representation of the respective systems.

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The international patent applications WO98/24214, WO0133904 and WO00/21330, all to Andersen, and the European patent application EP 0 909 110 to Backman, all present attempts to minimize such impedance differences, by introducing various openings in a housing containing the respective transducer, in order to achieve a system that is so called "leak-tolerant", i.e. tolerant to air leakages between a user's ear and the face on the communication device designed to be held against said user's ear. These patent applications propose various ways to connect the transducer to the air surrounding the respective

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transducer.

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However, this kind of approach gives rise to distortion either when the transducer is driven in alert mode or when it is used in phone mode. This is due to impedance mismatch and the approach, to minimize the influence of the user's on the performance of a communications device, is not adequate in order to achieve an essentially distortionless performance in both alert and phone mode of said portable communication device.

The patent application US2002/0136398 A1 discloses an earpiece which is claimed to produce amplified low-frequency characteristics in handsfree mode and a good sound by way of the earpiece being leak-tolerant, in discrete mode. The amplified low-frequency characteristics is due to constructive interference between sound waves from the front and sound waves from the rear of the transducer of the earpiece; a common base reflex earpiece is hence provided. By provision of apertures through a wall of a casing, the response curve in discrete mode becomes relatively insensitive to leaks, making the earpiece leak-tolerant.

The UK Patent Application GB 2 310 559 A discloses a loudspeaker housing having a transducer that is arranged to convey audio signals through an orifice, where said transducer is displaced from the orifice and where sound directing means defining a transmission path within the housing, and being arranged to direct sound from the audio generating means to the orifice, is provided. This loudspeaker housing thus provides an alternative to placing the transducer in direct contact behind an orifice usually adjacent to a user's ear. For transducers arranged behind an orifice, relatively small holes or perforations can be provided to protect the transducer from mechanical intrusion. However, such holes or perforations present acoustic resistances and impede the transmission of sound, why the loudspeaker disclosure of GB 2 310 559 is beneficial. Moreover, positioning a transducer directly behind an orifice place additional constraints upon the location of components within the printed circuit board, due to vibration effects.

There is thus a need for providing an electro-acoustic communications unit that is capable of producing acoustic signals in alert mode and in phone mode with a desired frequency performance, essentially without distortion.

SUMMARY OF THE INVENTION

The invention is thus directed towards solving the problem of providing an electro-acoustic communications unit presenting a desired frequency characteristics, essentially without distortion, despite the impedance differences experienced by the unit in alert mode as compared to phone mode.

A solution to this problem is achieved by actively making use of the change in the impedance of the acoustic port caused by holding said electro-acoustic communications unit close to a user's ear.

A first object of the present invention is to provide an electro-acoustic communications unit that actively makes use of the change in impedance of the acoustic port caused by holding said electro-acoustic communications unit close to a user's ear.

According to one aspect of this invention, this object is achieved by an electro-acoustic communications unit, comprising: a housing with a wall defining an interior, having a certain volume, and an exterior, an acoustic driver for generating acoustic signals, said acoustic

driver being mounted to the wall, and an acoustic port, having a length and a cross-sectional area, said port penetrating through the wall and connecting the interior of the housing with the exterior of said housing,

5 where the volume, length and cross-sectional area are dimensioned in relation to the acoustic driver in a way such that said electro-acoustic communications unit achieves a desired frequency characteristics when engaging the exterior end of said acoustic port of the communications unit with a user's ear.

10 A second aspect of the present invention is directed towards the electro-acoustic communications unit including the features of the first aspect, wherein the housing defined by the wall is tightly sealed.

15 A third aspect of the present invention is directed towards the electro-acoustic communications unit including the features of the first aspect, wherein the acoustic driver has an interior side and an exterior side, with respect to the wall, and that the interior side of the driver drives acoustic signals into the interior of the housing.

20 A fourth aspect of the present invention is directed towards the electro-acoustic communications unit including the features of the third aspect, wherein the acoustic port makes use of the acoustic signals driven into the interior of the housing.

25 A fifth aspect of the present invention is directed towards the electro-acoustic communications unit including the features of the third aspect, wherein the acoustic signals generated by the exterior side of the driver, are directed to dissipate without being used by the user.

30 A sixth aspect of the present invention is directed towards the electro-acoustic communications unit including the features of the first aspect, wherein the volume is of the order a few between 0,5 and 10 cubic centimeters (cm^3), the length of the acoustic port of the order of a few between 0,5 and 20 centimeters (cm) and the cross-sectional area of the order of between 1 and 120 square millimeters (mm^2).

35 A second object of the present invention is to provide a portable communication device that actively makes use of the change in impedance of the acoustic port caused by holding said portable communications device close to a user's ear.

40 According to the seventh aspect of this invention, this object is achieved by a portable communication device, comprising the electro-acoustic communications unit having a housing with a wall defining an interior, having a certain volume, and an exterior, an acoustic driver for generating acoustic signals, said acoustic driver being mounted to the wall, and an acoustic port, having a length and a cross-sectional area, said port penetrating through the wall and connecting the interior of the housing with the exterior of said housing,

where the volume, length and cross-sectional area are dimensioned in relation to the acoustic driver in a way such that said electro-acoustic communications unit achieves a desired frequency characteristics when engaging the exterior end of said acoustic port of the communications unit with a user's ear.

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An eighth aspect of the present invention is directed towards the portable communication device including the features of the seventh aspect, wherein the device is a mobile phone.

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A ninth aspect of the present invention is directed towards the portable communication device including the features of the seventh aspect, in which the acoustic signals generated by an exterior side of the driver, with respect to the housing wall, are attenuated by said device.

The present invention has the following advantages:

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Firstly, the main merit is that electric signals can be reproduced as acoustic signals both in alert and phone mode essentially without distortion.

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Secondly, as the above reproduction can be achieved by using one transducer only, space is saved within any device containing said electro-acoustic communications unit. Also, since the acoustic port typically has a diameter smaller than that of the transducer itself, and that the useful acoustic signals are forwarded by said port, exterior area space is saved, that in general is occupied by the transducer area.

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Thirdly, since one transducer can be used instead of two, the transducer cost can be reduced.

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Worth noting is that combining two functions in the same communications unit, often result in a compromise of both functions. The paradox with the preferred embodiment of the present invention is that both modes are improved as compared to that of an individual stand alone configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

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The present invention will be clearly understood from the following description of the preferred embodiments of the present invention, read in conjunction with the attached drawings in which:

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Fig. 1 presents an electro-acoustic communications unit according to a preferred embodiment of the present invention.

Fig. 2 shows a side-view of a portable communication device according to a preferred embodiment of the present invention, in the form of a mobile phone.

Fig. 3 shows a front-view of a portable communication device according to a preferred embodiment of the present invention, in the form of a mobile phone.

DETAILED DESCRIPTION OF THE EMBODIMENTS

5 The present invention relates to an electro-acoustic communications unit and a portable communication device for producing a desired frequency characteristics in alert and phone mode. It is also directed to solving the problem of providing said electro-acoustic communications unit and said portable communication device presenting a desired frequency characteristics, despite the impedance differences experienced by the unit, itself or within the
10 device, in alert mode as compared to phone mode.

With reference to Fig. 1, showing a communications unit according to a preferred embodiment of the present invention, said invention will now be described in more detail.

15 The electro-acoustic communications unit, 10, as presented in fig. 1, comprises a housing defined by a wall, 12, an acoustic transducer, 14, and an acoustic port, 16, which port connects the interior of the housing to the exterior of the housing. In fig. 1, a human ear, 18, placed in close proximity to the external end of the acoustic port, is also schematically
20 presented.

The housing defined by the wall, 12, of the electro-acoustic communications unit, 10, is a sealed housing having an interior with a volume, V. The housing is however designed with two holes, of which the acoustic port, 16, penetrates the wall, 12, through one of said two holes, and of which the other hole is provided to be covered by the acoustic transducer, 14,
25 mounted to the wall, 12. The housing formed by the wall, 12, is preferably tightly sealed, that is air tight, in order to achieve the desired frequency characteristics and highest sensitivity of the electro-acoustic communications unit according to a preferred embodiment of the present invention.

30 As is clearly shown in fig. 1, the acoustic transducer, 14, is mounted to the wall, 12, covering one of said two holes, so that the acoustic signals generated by one side of the acoustic transducer are transmitted into the volume of the housing. The acoustic signals that are not transmitted into the volume, V, but rather generated by the opposite side of the acoustic transducer are not useful and are hence not used in the present invention.

35 These acoustic signals can for instance be attenuated by attenuating means or by an outer shell of a communications device, in which the electro-acoustic communications unit, 10, is placed.

40 In Fig. 1, the acoustic port, 16, penetrating the wall, 12, is mounted on a side of the wall, 12, which side is opposite to the side of the wall, 12, of the transducer, 14. The port, 16, can however be mounted on any side of the wall, 12, as long as the acoustic port, 16, penetrates said wall, 12.

According to the present invention the impedance difference mentioned above is actively taken into account and represents the key to this solution of the problem of providing an electro-acoustic communications unit, with which an essentially distortionless performance in both alert and phone mode, is achieved.

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By properly designing the electro-acoustic communications unit according to a preferred embodiment of the present invention, said unit can be tuned to achieve a desired frequency characteristics of the output acoustic signals from the acoustic port.

10 The design of the electro-acoustic communications unit improves the performance of the alert as well as the phone mode. The alert mode improvement enables high acoustic signal sound pressures without huge cone excursions that cause distortion. In the alert mode the acoustic port, 16, is used as is, that is the impedance of the acoustic port itself is utilized. The improvement of the phone mode, realized by making use of the impedance influence by the user's ear close to the acoustic port, of the device held close to the ear, is an increase of the high-frequency (up to approximately 3 kHz) performance level relative to the performance of a communications unit alone.

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Also, the improvement of the phone mode is constituted by an improved low-frequency characteristics, that is an increase of the low-frequency level performance. For example, for a selected acoustic transducer the lower cut-off frequency, at which the acoustic signal intensity has decreased by for instance 3 dB, was lowered from ca. 750 Hz to ca. 300 Hz.

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25 Figs. 2 and 3, shows a side-view and a front view, respectively, of a portable communication device according to a preferred embodiment of the present invention, in the form of a mobile phone. The mobile phone, 20, of Fig. 2, contains an electro-acoustic communications unit, in which the housing, 24, and the acoustic port, 26 are shown. The cross-sectional area A is also indicated with 22. In Fig. 3 the cross-sectional area, 32, of the mobile phone, 30, is clearly shown.

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The tuning of the electro-acoustic communications unit according to the present invention is performed by using a method that is used for vented box solutions that is for bass-reflex loudspeakers systems.

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The description is of a basic normal procedure on how to tune a loudspeaker housing with a reflex port, but with amendments on what to consider when one or more reflex ports are intended to work as an earphone wave-guiding port.

40 The following paragraphs will thus describe the tuning in more detail. Two parameters have to be considered when selecting an acoustic transducer. These are the acoustic transducer's free field resonance frequency f_0 and its compliance C_a . A transducer having too high a resonance f_0 will not obtain a desired result. If the compliance C_a is chosen too high it will infringe the dynamics and will not be possible to use for obtaining a desired result in the wave-guiding

port. Having determined these parameters, a housing having an appropriate volume V_{box} can be realised.

5 When mounted in the housing the acoustic transducer obtains a resonance frequency f_{box} that has to be assessed such that the wave-guiding port can be calculated to create a Helmholtz resonator having an adequate resonance frequency f_H .

10 The Helmholtz resonance frequency f_H has to be chosen in the interval between the transducer's free field resonance frequency f_0 and the housing's resonance frequency f_{box} . If this interval is very narrow, the volume of the housing is probably too big and/or the transducer has too low a compliance C_a .

15 Moreover, the resonance f_H and a damping $1/Q_H$ of the Helmholtz resonator have to be chosen in a way so that the transducer when being mounted still can reproduce low frequencies below the resonance frequency f_H . This is essential if the wave-guiding port is intended to work as an earphone feeder. If the acoustic transducer can not produce this these frequencies sufficiently well, the transducer has been wrongly chosen.

20 The ratio between the cross-sectional area, A , and the length, L , of the port is determined by using Helmholtz equation. The length, L , of the wave-guiding port can be adjusted to suit a desired application provided the cross-sectional area, A , is adjusted according to Helmholtz equation. This thus implies that the length of the port can be relatively freely chosen.

25 In a first example of an earphone model, according to the invention, an acoustic transducer having a diameter of ca. 15 mm was used. The volume of an adequate housing was determined to ca. 2 cm^3 , and the length and diameter of the acoustic port were determined to 15 mm and 3 mm, respectively. In a second example using the same acoustic transducer and the same volume of the housing, the length and the diameter of the acoustic port were determined to ca. 110 mm and ca. 8 mm, respectively.

30 As indicated above, keeping the volume of the housing and the frequencies fixed, the individual values of the length and the cross-sectional area can be altered, provided that the ratio between the two, is kept fixed.

35 An interesting observation is that the desired frequency effect can be produced by using a wave-guiding port having an air volume 2,5 times the size of the volume, V , of the housing.

40 It is emphasized that this invention can be varied in many more ways, of which the alternative embodiments below only are examples of a few. These different embodiments are hence non-limiting examples. The scope of the present invention, however, is only limited by the subsequently following claims.

According to another embodiment of the present invention, multiple acoustic drivers are mounted in the housing, for generating the acoustic signals. Multiple acoustic transducer must for obvious reasons be considered in the dimensioning and tuning of the electro-acoustic communications unit.

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According to another embodiment of the present invention, multiple acoustic ports are provided, between the interior and the exterior of the housing, penetrating the wall of the housing. This implies that the acoustic signals from the exterior end of these ports are taken into account in the dimensioning and tuning of the electro-acoustic communications unit, and

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that acoustic signals from both ports are considered.

CLAIMS

1. An electro-acoustic communications unit (10) for producing a desired frequency characteristics in alert and phone mode, comprising:

- a housing with a wall (12) defining an interior, having a certain volume (V), and an exterior,
- an acoustic driver (14) for generating acoustic signals, said acoustic driver (14) being mounted to the wall (12),
- an acoustic port (16, 26), having a length (L) and a cross-sectional area (A), said port (16, 26) penetrating the wall (12) and connecting the interior of the housing with the exterior of said housing,

characterized in that

the housing defined by the wall (12) is tightly sealed and that the volume (V), length (L) and cross-sectional area (A) are dimensioned in relation to the acoustic driver (14) in a way such that said electro-acoustic communications unit (10) achieves a desired frequency characteristics in the phone mode, that is when engaging the exterior end (22, 32) of said acoustic port (16, 26) of the electro-acoustic communications unit (10) with a user's ear (18), wherein said desired frequency characteristics comprises an increase of the high-frequency performance level relative to the performance of a communications unit alone.

2. The electro-acoustic communications unit (10) according to claim 1, wherein the acoustic driver (14) has a first side directed towards the interior of the housing defined by the wall (12), and a second side directed towards the exterior of the housing defined by the wall (12), and

characterized in that

the first side of the acoustic driver is arranged to drive acoustic signals into the interior of the housing.

3. The electro-acoustic communications unit (10) according to claim 2, characterized in that

the acoustic port (16, 26) is adapted to make use of the acoustic signals driven into the interior of the housing.

4. The electro-acoustic communications unit (10) according to claim 2, characterized in that

the acoustic signals generated by the second side of the acoustic driver (14), are directed to dissipate without being used by the user.

5. The electro-acoustic communications unit (10) according to claim 1, characterized in that

the volume (V) of the housing is of the order a few between 0,5 and 10 cubic centimeters (cm^3), the length (L) of the acoustic port (16, 26) of the order of a few between 0,5 and 20 centimeters (cm) and the cross-sectional area (A) of the acoustic port (16, 26) of the order of between 1 and 120 square millimeters (mm^2).

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6. Portable communication device (20, 30) comprising an electro acoustic communications unit (10) according to claim 1.

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7. Portable communication device (20, 30), according to claim 6, wherein the portable communication device is a mobile phone.

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8. Portable communication device (20, 30), according to any of claims 6 or 7, characterized in that said portable communication device (20, 30) is adapted to attenuate the acoustic signals generated by an exterior side of the acoustic driver (14), with respect to the housing wall (12).